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An IoT Based Monkey Deterrent for Plantations with Surveillance System: A Method for Damage Controldone by Monkeys in Plantations

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Abstract

Modern civilization's rapid growth requires humans to cohabit with other species, notably primates. Many farmers and plantation owners struggle with primates, which undermine crop harvests. The most frequent monkey pest in Malaysia is the Southern Pig-tailed Macaque. This project was created to control monkey damage and deter them from farms and plantation areas. This paper describes an Internet of Things (IoT)-based sound deterrent system. The ESP32 acts a the main controller while ESP32-Cam acts as the surveillance apparatus for the device. This prototype is designed to deter away monkeys while providing a remote method of surveillance paired with ESP32-Cam and PIR sensor.

1. Introduction

Macaca fascicularis is a species commonly known by various names such as long-tailed macaque, crab-eating macaque, and Kera (in Malaysia). The species in question exhibits a wide distribution throughout Southeast Asia, encompassing territories such as Malaysia, Brunei, Singapore, Indonesia, Bangladesh, Cambodia, Thailand, Vietnam, Laos, Myanmar, Timor-Leste, the Philippines, and small islands situated in the South China Sea and Indian Ocean. It is widely regarded as the most prosperous non-human primate species in the region. [1]

The significant presence of macaques in Malaysia poses a central challenge in the context of human-wildlife conflict. In this particular context, the macaques coexist with plantation owners or farmers who manage plantations that are naturally located in close proximity to forests. This issue arises when macaques are provided with unrestricted access to plentiful food resources, such as the crops grown on the plantation. Given the issue at hand, farmers may opt to implement deterrent strategies, such as the utilization of firecrackers, in order to dissuade the macaques from encroaching upon their land. Empirical evidence suggests that this approach is efficacious, albeit labor-intensive, as it necessitates the physical presence of the farmer or plantation proprietor to execute the task.[2]

Consequently, the implementation of a system that facilitates remote deterrence of potential pests, particularly monkeys, and the provision of adequate surveillance for plantations is vitally important.

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1.1 Problem Statement

Nowadays, traditional methods of monkey deterrent are still being used such as firecrackers to deter the monkeys away, monkey traps to further frighten the monkey away from the plantation area. Even dogs are traditionally used to guard the plantation area. All these methods require labor of some sort, either human labor or animal labor to do so. These methods are undeniably effective to a certain extent. But the main factor that they lack is the surveillance of the farmers or plantation owner themselves. There should be a system to enable both factors that they need, deterrent and surveillance.

Thus, providing a sound based deterrent system and surveillance will help alleviate the problem of macaque infestation at hand. This system will enable them to remotely deter the macaque and provide surveillance at their plantation area. Moreover, this system will enable the users to do it remotely.

1.2 Objectives

a) To develop a functional surveillance system for plantation workers and owners.
b) To develop a sound based deterrent system to help deter out potential pests.
c) To design an IOT based pest deterrent system that is integrated with BLYNK application.

1.3 Scopes of Study

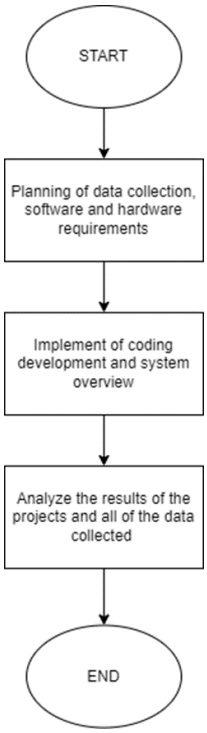
To direct the progress of this project in the direction of achieving its goals, three different scopes have been established. The following is a summary of the scopes:
a) Design a complete model for the surveillance system that includes the design, components and connections.
b) Develop a functioning sound based deterrent system to mitigate crop damage done by monkeys in plantation areas and combining it with a proper surveillance system.
c) Validate the efficiency of the prototype in damage mitigation, evaluate real -world application, simulate real – time monitoring and to record IOT integration with the system responsiveness.

2. Materials and Methods

No	Part Name	Qty	Function	Cost (RM)
1	NodeMCU ESP32	1	Used as microcontroller board for the device	RM 23.90
2	ESP32-CAM	1	Used as a surveillance camera	RM 25.90
3	ESP32 V1 Shield	2	Houses the ESP32 and ESP32-Cam, to cater connection	RM 9.00 x 2 = RM 18.00
4	Button	1	Used as a reset switch	RM 1.00
5	12V Power Adapter	1	Used as a power input	RM 8.00
6	Voltage Divider	1	Used to divide the 12V power input	RM 2.90
7	PIR Sensor	1	Used to detect motion	RM 20.50
8	12C OLED	1	Used to display device startup info	RM 12.90
9	DF Player Module	1	Used to house SD card to install audio inputs	RM 5.99
10	Speaker	2	Used as the sound output	RM 6.90
11	Jumper Wire	2	Used to connect the device's components	RM 3.70 x 2 = RM 7.40
12	Electrical Box	1	Used to house all of the components	RM 22.50

2.1 Project Flowchart Diagram

This project was carried out in three main stages, beginning with planning, implementing, and assessing. All of the approaches that were applied to find and evaluate data relating to the project that was linked.



(a)

Fig.1 *Flow Chart of Project*

2.2 System Flowchart

Figure 2 shows the two main functions of this system are the surveillance system and the sound deterrent system. The system starts by having the user check the Blynk application to determine if the application is connected to the device. If there's no connection, the user should check firsthand if the device is properly powered up or turned on. If the device is not popping up in the Blynk application, the user needs to check the connection between the device and the Blynk application. If the connection was properly done, the Blynk application will prompt a display showing the surveillance footage in real-time.

Next up, the sound deterrent system. Based on the user itself, the user is able to choose between two configurations, whether manually or automatically. For manually, the user is able to choose preferred sound to be played to deter away potential pests from the plantation area. For automatic configuration, the device itself will play a preset list of sounds to be played. The device itself will randomly play a curated list of four to five sounds to be played. The device won't play the sounds throughout when the system is turned on, but it will obey the timer that was set by the user itself.

Next on the list, the motion detection system. The device will send out notifications to the user via the BLYNK application to notify the user of movements within the vicinity of the device. In this context, in an area in front of the device in a 180 degrees manner.

For the timer part, the user will determine how long one sound will be played and the duration of the next sound to be played. This provides the freedom for the user to choose the appropriate duration of the sound to be operational. All of these functions are to be seamlessly integrated with the Blynk app. So, the user has full accessibility to all the functions the device offers in one device or multiple registered devices.

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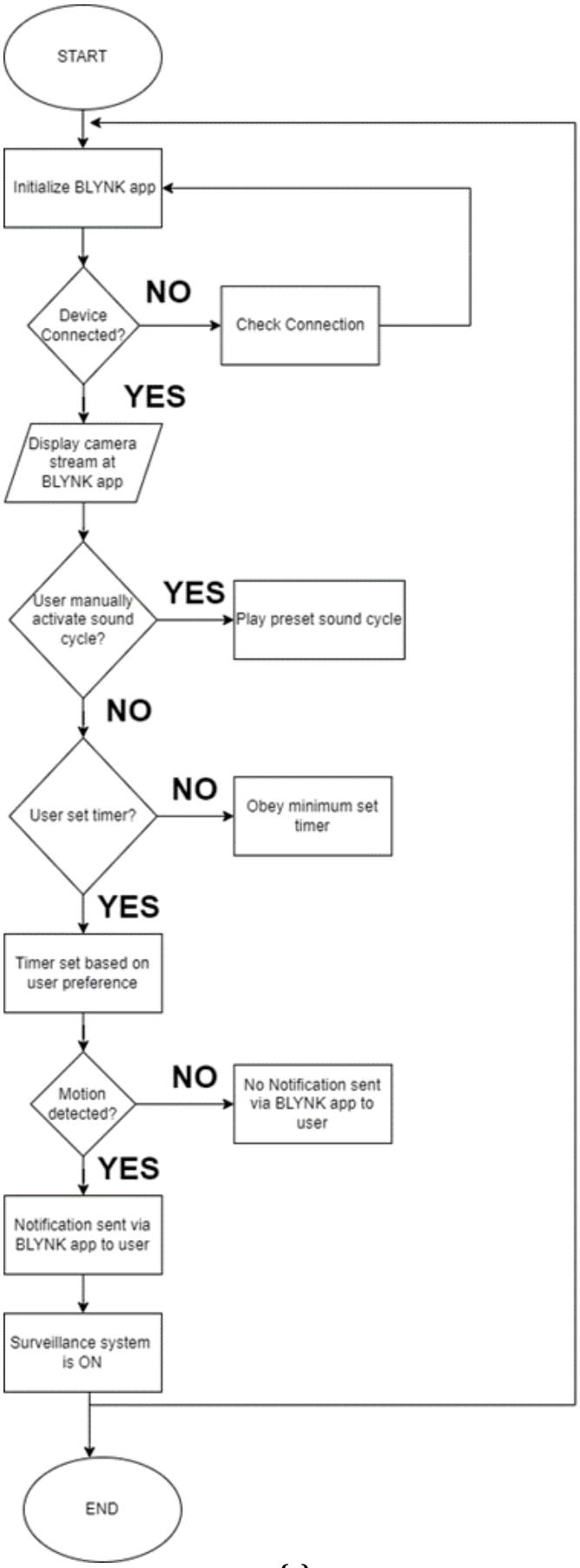
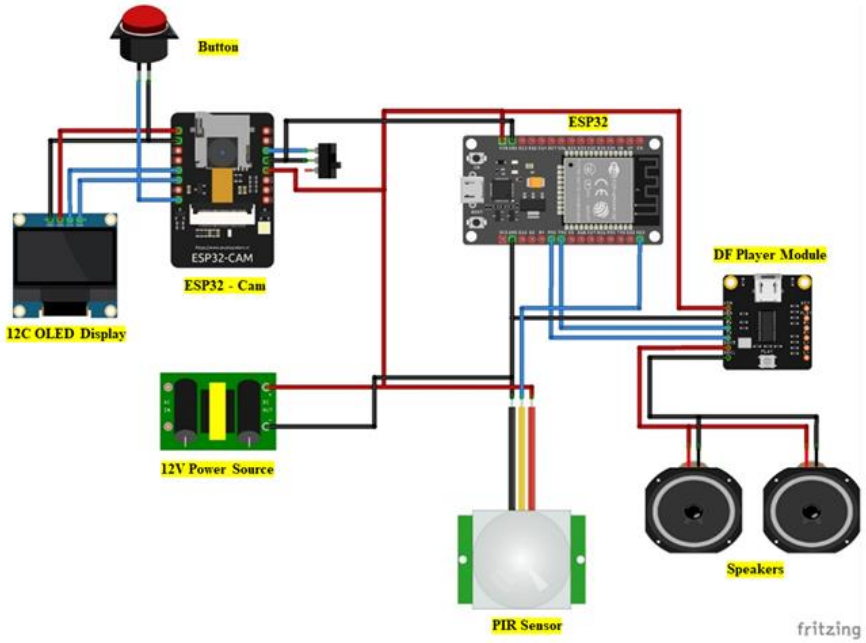


(a)

Fig.2 *System Flowchart of Project*

2.3 Simulation Circuit Diagram

Figure 3 shows the simulation circuit diagram that was developed via the Fritzing software. The pictorial diagram shows the whole connection of the device. In this connection, we are able to see that we use the speakers as our main audio output for the device. The device is powered by a 12V power source. The connection also shows the ESP32, ESP32 – Cam, 12C OLED Display, a DF Player module to store in the audio files and also the detection sensor, PIR Sensor. The 12C OLED Display is used to display messages such as the wi-fi source for the device and also the URL link for the ESP32 – Cam stream for the BLYNK application.



(a)

Fig.3 *Simulation circuit diagram*

3. Results and Discussions

3.1 Results

The main emphasis of this chapter is to discuss the outcome of the project where the analysis and experimentation are being conducted to test the effectiveness of the sound-based monkey deterrent surveillance system. A few methods are conducted in software and hardware including the programming works to test the components and systems to ensure a full working device or prototype is fully operational.

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(a) **(b)**

Fig.4 *a) The Sound Deterrent Device b) Notification Prompt on User Device*

The PIR Sensor detects if there are any object or subject matter movement that passes in front of the device, it will prompt the device to send out notifications to the user. The user can access the device quickly via clicking on the notification panel and it will link the user to the Blynk application.

In the Figure 4, It shows the device is able to send out the notifications when there is a subject matter in front of the device. This able the user to quickly jump into the BLYNK app to initiate the deterrent audio to scare off the potential pests. As a test, I went on to stand in front of the device to showcase and prompt the motion detection and notification function of the device.

Table 1 shows the data that was gathered regarding the number of monkeys within the vicinity of the device placed in the area. The audio that was emitted from the device has potential to cause the monkeys to be scared and also confused as they tried to find the source of the barking sounds that was emitted from the device. The numbers of monkeys varies as they portrayed different behaviours on how they reacted to the sound emitted by the device.

The data analysis reveals clear temporal patterns in the monkey population's reaction to the audio stimulation. Significantly, between 10.00 AM and 10.15 AM, the number reduced from 7 to 5 following the playback of the audio. This decrease suggests the possibility of a dispersal or avoidance reaction to the unusual barking sounds.

During the midday hour (11.00 AM – 11.15 AM), a consistent pattern is noticed where the count decreases from 4 to 3 following the audio emission. This observation suggests that the monkeys may exhibit an increased sensitivity or cautious behavior during the daytime.

Curiously, there is a continuous decline in the monkey population throughout the evening time slots of 5.00 PM – 5.15 PM and 6.00 PM – 6.15 PM following the playback of the audio. Although the decrease is not significant, it indicates a lasting effect on the monkeys' behavior, which could potentially affect their mobility or presence.

Table 1 *The Numbers of Monkeys Present Before and After Audio Played*

Testing Period (Time)	Numbers of Monkey Present	
	Before Audio Played	After Audio Played
10.00 AM – 10.15 AM	7	5
11.00 AM – 11.15 AM	4	3
5.00 PM – 5.15 PM	5	4
6.00 PM – 6.15 PM	7	5

4. Conclusions

In summary, the audio-based monkey deterrent device has successfully achieved its goals, meeting the demand for both all-encompassing surveillance and the use of audio-based deterrent mechanisms to deter monkeys. The principal objectives of this project were to create a gadget that possessed motion detecting capabilities, audio deterrent elements, and user-friendly notification functions.

The gadget is protected by a casing that places its audio and motion detection sources in the front of the device. Incorporating an ESP32-Cam into this arrangement allows customers to receive visual results immediately through the BLYNK application. Through this integration, the device's surveillance capabilities are improved, guaranteeing an effective approach to keep monkeys out of the targeted area.

The audio-based monkey deterrence device is particularly good at motion detection and notifies users right away if it detects any activity. One of the main features of the device that effectively deters monkeys and adds to its overall efficacy is the acoustic deterrent's effectiveness. The device's surveillance capabilities are improved by the smooth coordination between the audio and video components, providing a comprehensive solution to problems associated with monkey infestation.

While acknowledging the project's achievements, it's important to take a few things into account. Additional consideration should be given to elements including the acoustic deterrent's range of effectiveness, possible environmental effects on motion detection precision, and any impediments influencing the device's operation. Even though these areas need more research, they don't overwhelm the device's accomplishment in fulfilling its goal of offering a dependable and effective monkey deterrent.

All things considered, the audio-based monkey deterrent gadget provides an effective method of deterring monkeys by combining audio-based mechanisms, motion detection, and user notifications. The device's overall success in accomplishing its intended goals is largely due to the thoughtful arrangement of its components and the incorporation of visual streaming capabilities via the BLYNK application. This project presents a viable way to reduce human-wildlife conflicts and establishes the foundation for future advancements in the field of wildlife deterrent technologies.

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